50. The Brain and Brain-Case of a Fossil Ungulate of the Genus *Anoplotherium*. By R. W. PALMER, M.Sc. (Manchester), Research Fellow in Zoology, University College, Reading *.

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(Text-figures 150–157.)

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For some time a cranium from the Phosphorites of Quercy, together with an exceptionally perfect and well-marked brain-cast obtained from it, has been awaiting description in the British Museum. The cast was submitted to Prof. G. Elliot Smith, F.R.S., of Manchester, who intended to describe it, but he was prevented from so doing by the pressure of other work, and very generously passed it, together with the notes he had made on it, to myself. By the courtesy of Drs. Smith Woodward and C. W. Andrews, of the British Museum, I have been allowed to describe both the skull and brain-cast.

The whole of the facial region of the specimen is missing, and since the dentition of mammals forms such an excellent guide to affinities that in original descriptions cranial features are for the most part entirely overlooked, the identification of a toothless skull such as this is a matter of difficulty. A study of the literature of the subject and of such specimens as are available, however, leaves little doubt as to the genus of the creature.

The skull is broken away at the back of the orbits, and the paroccipital, zygomatic, and pterygoid processes are incomplete. In *dorsal view* (text-fig. 150) it is seen to be narrow, elongate, and somewhat fusiform. Its greatest width in front of the zygomatic processes is 49 mm., but behind the orbits it is greatly constricted and its width reduced to less than one half, or 23 mm. At the back of the zygomata, not including the lambdoid ridge, it measures 40 mm. across. The marked postorbital constriction is by no means uncommon in early Tertiary mammals, and indicates at once a poor development of the frontal lobes of the hemispheres.

The most striking feature of the dorsal surface of the cranium, however, is the great strength of the sagittal and lambdoid crests. The former arises in front by the union of the two low postorbital ridges on the frontals, and traverses the whole length of the brain-case as a knife-like ridge which rises as high as 16 mm. above the general surface. As it nears the occiput the crest somewhat thickens and meets the equally highly developed and more massive lambdoid crest at right angles.

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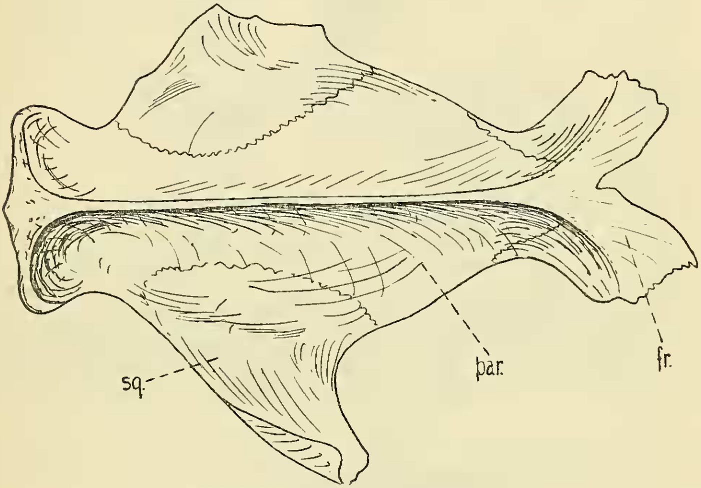
* Communicated by Dr. C. W. ANDREWS, F.R.S., F.Z.S.

The root of the zygomatic process is very extensive and slightly convex antero-posteriorly. Its widely concave form in a transverse direction indicates a temporal arcade standing well out from the skull.

Text-fig. 150.



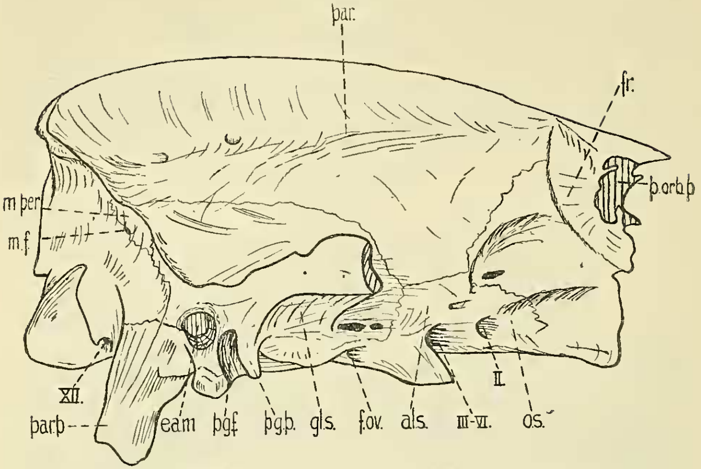
Dorsal view of skull of *Anoplotherium.*

fr., frontal; *par.*, parietal; *sq.*, squamosal.

In *lateral view* (text-fig. 151) the great height of the sagittal and the true form of the lambdoid crests are displayed. This latter strikes off at right angles to the sagittal for about 2 cms., slightly dropping in elevation as it does so, then falling very sharply downwards, forwards, and slightly inwards, is continued as a much less pronounced ridge to the posterior root of the zygoma. Here it bifurcates, the anterior branch being an extension of the vertical flange of the zygomatic process, while the posterior runs down, and slightly back, on to the huge paroccipital process, on which it dies out. The aperture of the external auditory meatus between the paroccipital and zygomatic processes is remarkable in being formed above by a groove in the squamosal, while the tympanic forms its floor alone, there being no ordinary bony tube.

In *occipital view* (text-fig. 152) the foramen magnum is seen to be nearly circular and the condyles massive. Above, the lambdoidal crest forms a large shield-shaped area much roughened for

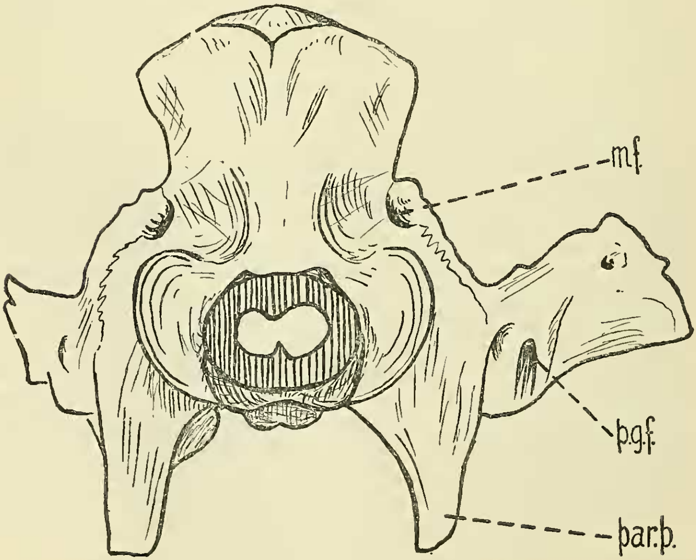
Text-fig. 151.



Lateral view of skull of *Anoplotherium*.

als., alisphenoid; *e.a.m.*, external auditory meatus; *f.ov.*, foramen ovale; *gl.s.*, glenoid surface of the squamosal; *m.f.*, mastoid foramen; *m.per.*, mastoid portion of periotic; *o.s.*, orbitosphenoid; *par.*, parietal; *par.p.*, paroccipital process; *p.g.f.*, post-glenoid foramen; *p.g.p.*, post-glenoid process; *p.orb.p.*, post-orbital process; *II.*, optic foramen; *III.–VI.*, united sphenoidal fissure and foramen rotundum; *XII.*, condylar foramen.

Text-fig. 152.

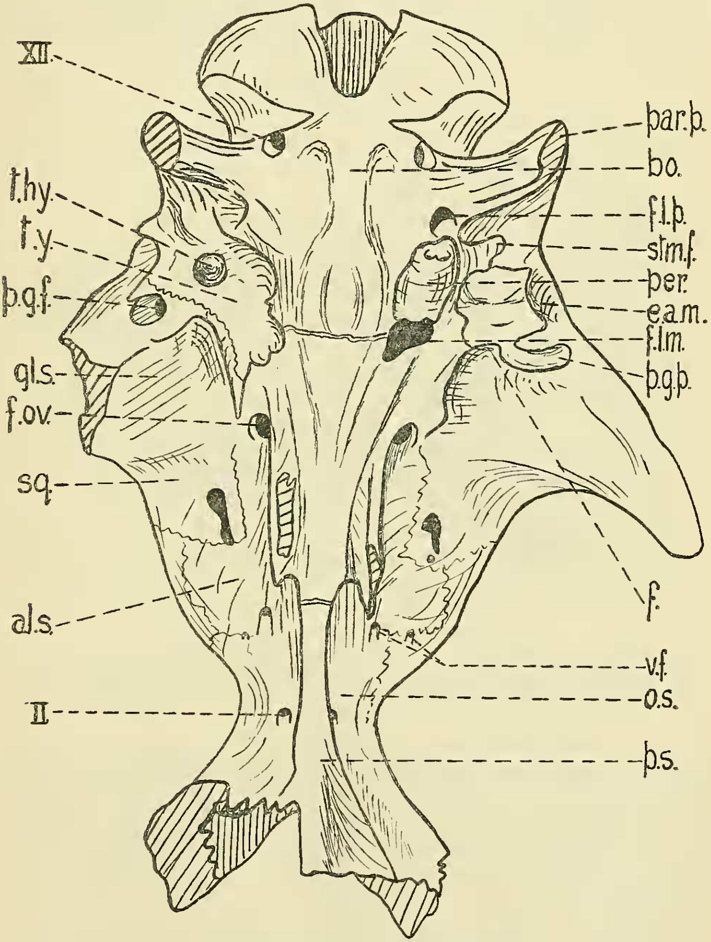


Occipital view of skull of *Anoplotherium*.
Lettering as in text-fig. 151.

muscular attachments. The paroccipital processes are seen to diverge slightly below.

The *palate* (text-fig. 153) is very long and narrow. The glenoid surfaces of the squamosals are large and flat with strong post-glenoid processes. On the left side the tympanic has been preserved, while on the right this is conveniently missing, leaving

Text-fig. 153.



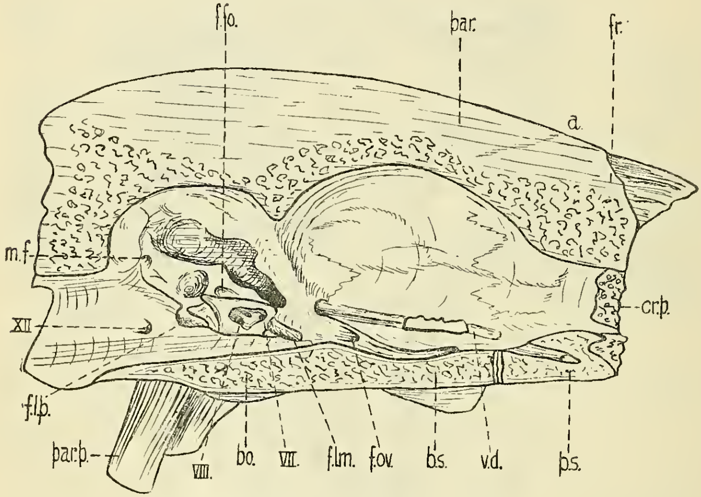
Palatal view of skull of *Anoplotherium.*

Lettering as in text-fig. 151, with addition of *bo.*, basioccipital; *f.*, venous foramen?; *f.l.m.*, foramen lacerum medium; *f.l.p.*, foramen lacerum posterius; *per.*, periotic; *p.s.*, presphenoid; *sq.*, squamosal; *stm.f.*, position of stylomastoid foramen; *t.hy.*, point of attachment of tympano-hyal; *t.y.*, tympanic; *v.f.*, canals for vessels of the diploë.

the lower surface of the periotic exposed. The secondary palate is completely lost.

In a *longitudinal section* of the skull (text-fig. 154) the great thickness of the bones and the general development of diploë are striking features. A skull which supported such massive temporal muscles as this beast possessed had of necessity to be of a strong build. The extreme shallowness of the pituitary fossa and the practical absence of clinoid processes are features of interest, while the mode of attachment of the cribriform mass to a groove in the pre-sphenoid is curious. The pear-shaped cerebral fossa is partly separated from the cerebellar by the heavy tentorial ridge, most of which belongs to the squamosal. The spacious cavity for the transverse sinus opens immediately behind this ridge above the periotic. It goes straight down to the post-glenoid foramen and is joined by a canal for a vein which ran in a deep groove on the side-wall of the skull, and was formed by the confluence of two vessels which ran in the substance of the alisphenoid.

Text-fig. 154.



Median section of skull of *Anoplotherium*.

Lettering as in preceding figures. with addition of *b.s.*, basisphenoid; *cr.p.*, cribriform plate; *f.fo.*, floccular fossa; *v.d.*, canal for vessel of diploë.

The main features of the individual bones of the skull will now be outlined.

The bones of the *occipital segment* are indistinguishably fused together, but their anterior sutures are for the most part distinct. The thick *supraoccipital* is of great extent owing to the extreme development of the lambdoid crest, of which it forms the entire upper portion. It articulates with the parietals by a jagged transverse suture anterior to this crest. The *exoccipitals* were also large bones, including, as they no doubt did, the large condyles and practically the whole of the paroccipital processes. They take no share in the lambdoid ridge, for their suture with the mastoid and squamosal lies just posterior to this ridge. It is a jagged line, starting at the base of the steep drop in the crest, and, travelling behind it, runs down on to the paroccipital process. The *basioccipital* is clearly marked off from the basisphenoid by a slightly irregular groove. It is very wide behind, between the paroccipital processes, and notched by the condylar foramina which must pierce the skull between it and the exoccipitals (text-fig. 153, p. 881). In front it is narrowed by the lacerate foramina and by the gap in which the periotic is set. Its lower surface is here heavily marked for muscular attachments. In section, the bone is seen to be thin and dense posteriorly, but in front it is thicker and more cancellous in structure (text-fig. 154).

The *parietals* are remarkably extensive, and externally they appear to form the entire cranial roof. Anteriorly, they considerably overlap the frontals, and the extent of this overlap can be seen in section (text-fig. 154), where the junction of the bones is indicated by a break in the structure of the roof (at "*a*" in the figure). The parietals do not share in the formation of the lambdoid crest, but meet the supraoccipital anterior to it. There is no trace of a distinct interparietal, and the strength of the sagittal ridge has necessitated a firm union of the parietals. The suture with the frontals is first seen as a jagged line on the postorbital ridge. It travels forwards along this for about 12 mm., then turns suddenly backward and curves down on the side of the skull till it strikes the alisphenoid. Below, the parietal is suturally connected with the alisphenoid along a short horizontal line, and posteriorly it is considerably narrowed by its bow-shaped suture with the squamosal (text-fig. 150, p. 879). Inside the skull, the fronto-parietal suture is seen as a very irregular line running vertically on the wall of the cerebral fossa, and the squamoso-parietal suture as an even more irregular line in front of the tentorium. Neither suture can be completely traced.

The *squamosal* forms a considerable part of the side-wall of the skull. Posteriorly it overgrows the mastoid, so that only a small isolated surface of this bone is exposed. The suture with the mastoid is anterior to the lambdoid crest, and as this bone gets submerged the suture crosses the crest to form the junction with the exoccipital. The squamosal sends a small vertical thin flange on to the root of the paroccipital process. It is partly anchylosed with the tympanic, and in front of the meatus is bored by the very large post-glenoid foramen. Almost the whole length of the bone is concerned in forming the zygomatic process, which is concave from side to side above, has a vertical flange to the exterior, and a flat glenoid surface below. The flange is roughened on its upper edge for attachment of the temporal fascia. To the inside of the glenoid fossa, where the squamosal meets the alisphenoid, there is a narrow ridge which both bones help to form, and which runs parallel to the middle line to separate the glenoid and tympanic cavities. Where this ridge meets the post-glenoid process there is a depression which may represent a venous foramen (text-fig. 153, *f.*, p. 881).

Seen from the inside the *periotic* is quite an extensive bone. The double openings of the internal auditory meatus and of the aqueductus Fallopii are seen in the centre of the lower triangular part. Above this, the floccular fossa (*f.fo.*) is excavated, and from this region the large mastoid portion inclines backwards. The mastoid part, as mentioned, is exposed on the outside of the skull only as a small island between the exoccipital and the squamosal, forming the lambdoid crest for about 1·5 cms. Through its suture with the exoccipital runs the small mastoid foramen (*m.f.*). The inferior surface of the petrosal portion is seen as a subovate mass inclined steeply outwards and jammed in between the basioccipital and squamosal. It separates the median and posterior lacerate foramina. Posteriorly it is pierced by the fenestræ rotunda and ovalis.

The *tympanic* is preserved on the left side. It is partly anchylosed to the squamosal, but not to the periotic. It consists of a small, very thick, uninflated bulla which does not meet the basioccipital, but projects freely under the petrosal. A cylindrical hollow on the bone represents the attachment of the tympano-hyal (*t.hy.*), and on the right side the position of the stylomastoid foramen (*stm.f.*) is seen to be immediately behind this. The rest of the bone forms an irregular mass below the meatus and presents no points of interest.

The *alisphenoids* are firmly fused with the *basisphenoid*, and the three bones must be taken together. The basisphenoidal part is very elongated—behind, it is wide and notched by the median lacerate foramina. In front, it narrows very considerably, and at the junction with the alisphenoidal part the vertical pterygoid wings arise. The alisphenoidal part is a hatchet- or L-shaped bone, having a narrow limb confined to the base of the skull between the squamosal and the basisphenoid and a square limb in front of this, forming part of the side wall of the skull and meeting the parietal above and the frontal in front. The long limb is deeply grooved for the Eustachian tube, and in its middle is perforated by the foramen ovale (*f.ov.*). Anteriorly, below the pterygoid flange, the bone is tunnelled by a canal which represents the united sphenoidal fissure and foramen rotundum (III.–VI.). A couple of venous foramina (*v.f.*) appear externally on the alisphenoid. These were traversed by the vessels which united inside the skull to form the large vein already mentioned as running into the transverse sinus. On its upper surface the alisphenoid is very deeply grooved to shelter the cranial nerves lying on it. These grooves are better seen from the cast. They will be mentioned later. In section, the basisphenoid is seen to be a thick bone, and it is scarcely thinned by the shallow pituitary fossa.

On the dorsal surface of the skull the *frontals* form a flat arrowhead-shaped area between the post-orbital ridges. Laterally they are concave. Below, they unite by suture with the ali- and orbito-sphenoids, and they extend well down on the skull since the palatines cannot be traced below them. Within the skull they form the division between the olfactory and cerebral cavities. In front and above they are hollowed out by the frontal air-sinuses.

The *orbitosphenoid* is quite small. Its suture with the alisphenoid is not plain, but it appears to completely surround the optic foramen. It is indistinguishably fused with the *presphenoid*, which is a very long and thin bone with a marked median palatal ridge. It is very thick, and its upper surface, as seen in section, is shaped like the roof of a house, that is, its surface is very high in its middle length and slopes down both forwards and backwards (text-fig. 154, p. 882). The posterior slope shares in the tunnel for the optic nerve, while the anterior one is excavated by a rounded, undercut hollow which gives a firm support to the cribriform plate (*cr.p.*). This last bone is a solid mass of perforated tissue and presents no special points of interest.

Comparison of the specimen with the figures given by Cuvier [1] and Blainville [2], as well as with the casts available at the British Museum, leaves little doubt but that the skull has been correctly identified. In Cuvier's figures the general form of the skull with the postorbital constriction, the form of the condyles, the immense paroccipital processes, the peculiar formation of the meatus, the post-glenoid process, its foramen, and a host of other details are identical. Fig. 1, pl. xlvi. of Cuvier's 1822 edition shows the upper surface of the base of the skull of an *Anoplotherium* determined from the teeth, and the arrangement of the foramina, of the grooves for the nerves, and of the transverse sinus agree precisely with this specimen. The agreement with Blainville's figures is no less conclusive, and though the crests on the skull are considerably stronger than those in any specimen figured by these writers, they are of the same form, and their degree of development can hardly be of greater than specific value when other features agree so markedly.

Support for the identification also comes from the brain-cast, for it agrees essentially with the natural one figured by Blainville on plate ii., but not with the one given by Cuvier (plate lv., 1822 edit.), which is incorrectly identified as an Anoplothere.

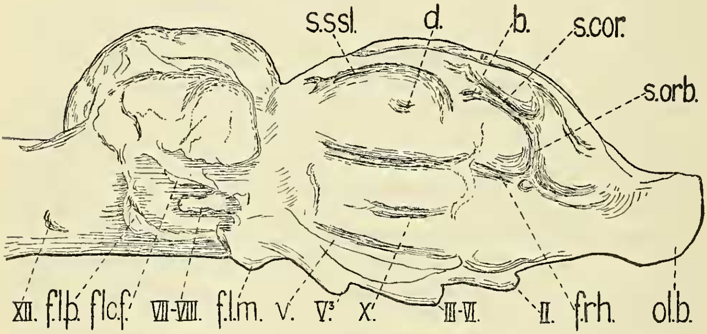
Brain-cast.

The narrow, elongate form of the skull is naturally also a feature of the brain. Its total length from the front of the olfactory bulbs to the caudal end of the cerebellum is a fraction under 10 cms. Of this total, the cerebrum accounts for 5·6 cms., the cerebellum for 3·35 cms., and the olfactory bulbs for the remaining 1 cm. The cranial capacity, as measured with sand from the cast, is 86 cc.

The parts of the cerebral hemispheres chiefly concerned with the sense of smell, are, as usual in early Tertiary mammals, highly developed. This is seen in the large size of the olfactory bulbs and of the rest of the "smell-brain," and in the small size of the neopallium. The greatest width of the cerebrum, which is near its caudal extremity, is 45 mm.

The cerebellum is separated from the hemispheres, but there is no evidence that the corpora quadrigemina were exposed. Its width cannot be measured accurately, owing to the casts of the cavities for the transverse sinuses being continuous with its mass on each side. Estimating the extent of these sinuses, its transverse is not much more than its antero-posterior diameter—that is, about 37 mm.

Text-fig. 155.



Lateral view of brain-cast of *Anoplotherium*.

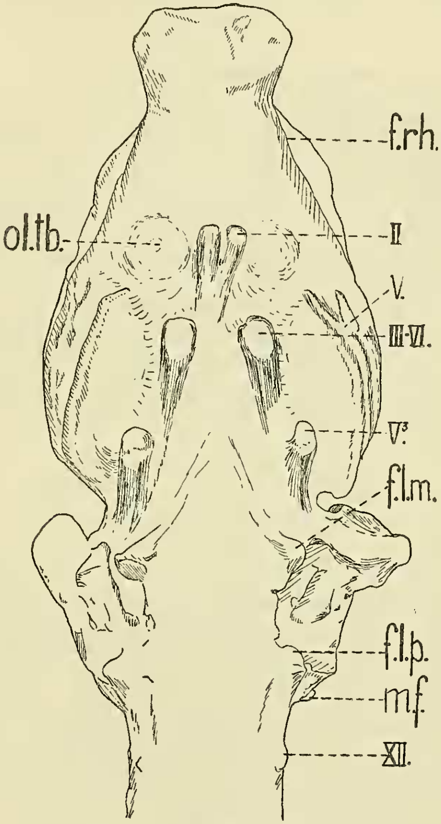
flc.f., floccular lobe; *f.l.m.*, cast of foramen lacerum medium; *f.l.p.*, cast of foramen lacerum posterius; *f.rh.*, rhinal fissure; *ol.b.*, olfactory bulb; *s.cor.*, coronal sulcus; *s.orb.*, orbital sulcus; *s.ssl.*, suprasylvian sulcus; *v.*, vessel; *II.*, *III.-VI.*, *V.*^{3}, *VII.-VIII.*, casts of foramina of cranial nerves.

Looked at in side view (text-fig. 155), the cerebellum stands as high above the axis of the brain as does the cerebrum. This is no doubt a primitive feature, for in recent Ungulates the hemispheres are distinctly more elevated than the cerebellum. The Middle Eocene *Palæosyops* agrees with *Anoplotherium* in this particular [**3**].

On the base of the brain the courses of the cranial nerves and the casts of the lacerate foramina are conspicuous, while below the floccular lobe on each side the periotic has left a ragged scar.

The brain, in general form, arrangement of parts, and furrows, is remarkably similar to that of *Orycteropus*. This is seen in side view, and especially from below. If the figure of the ventral surface of the brain of the Aard-Vark given by Elliot Smith [**4**] be compared with text-fig. 156, the similarity will be seen to be very striking. The detailed resemblances will be noticed below, and they undoubtedly help to strengthen the evidence in favour of a primitive Ungulate origin for the Tubulidentata—a view held by Elliot Smith, Max Weber, and Lönnberg.

Text-fig. 156.



Ventral view of brain-cast of *Anoplotherium*.

Lettering as in text-fig. 155, with addition of *m.f.*, mastoid foramen; *ol.tb.*, olfactory tubercle.

Ventral Surface of Cerebrum.

The whole of this region is well developed. This can be clearly seen from text-fig. 156, for, seen from below, the pyriform lobes almost completely conceal the neopallium—a part of which is visible only to the outside of the anterior parts of the pyriform lobes. *Anoplotherium*, then, was far more highly macrosmatic than any living Ungulate, and not much less so than the burrowing Aard-Vark.

The *olfactory bulbs* at their widest part are together 21 mm. across. The olfactory peduncles are distinct thick stalks, swelling out behind into the anterior ends of the pyriform lobes.

The *olfactory tubercles* are well shown as smooth circular elevations placed rather further back than in *Orycteropus*, and sufficiently prominent to be noticeable in a side view of the cast.

Between these tubercles the cast shows the course of the *optic nerves*. These tunnelled the base of the skull very near the middle line. The position of the chiasma is indicated by the sinking of these tubular casts on to the general level of the brain-surface. Diverging outwards from the chiasma, the valleculæ Sylvii are distinct, marking off the globular posterior parts of the pyriform lobes. Running back along the lower surface of each of these lobes is the cast of the vein described as running on the side of the cranium. This vessel does not seem to be cerebral, but rather to collect blood from the diploë of the bones. The only other feature on the pyriform lobe worthy of note is a short straight fissure running along it, above the vessel just mentioned, and below and parallel to the rhinal fissure. A similar fissure occurs in the pig and the tapir. In text-fig. 155 (p. 886) it has been marked with the letter "*x*."

Lateral Surface of Cerebrum.

The *olfactory bulbs* having been described from below need no further mention.

The *neopallium* is clearly marked off from the rest of the hemispheres by the great horizontal *rhinal fissure*. In text-fig. 155 there is a break in this fissure at about one-third of its total length from the front. This break does not occur on the other side, and seems to be due to damage of the skull-wall. In side view the rhinal fissure is seen to divide the hemisphere horizontally into two equal parts, and the primitive character of the brain is emphasized by the relatively small size of the upper part (neopallium) in comparison with the rest of the cerebrum. Its great development in the higher mammals, which led to the degeneration of the "smell-brain" and to its enwrapping by the neopallium, has scarcely begun.

About 17 mm. from the anterior end of the hemisphere, there is a vertical sulcus running into the rhinal fissure below, and connected, on the right side only, by a shallow furrow with the lateral sulcus. This sulcus can be no other than the *orbital* *. Its position, relation to the rhinal fissure, and its possible connection on the right side to the lateral sulcus are exactly like the conditions in the brain of *Orycteropus*.

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* I am using the same terms as were employed in the descriptions of the brain of *Orycteropus* [4], to which I have referred, although Dr. Elliot Smith tells me the whole question of nomenclature of cerebral sulci urgently needs revising in the light of recent research on anatomical localization of the cerebral cortex.

Behind the orbital, the side of the hemisphere is marked by a clearly defined sulcus, rather under 2 cms. in length, and running obliquely from behind forwards and downwards to join the orbital. This sulcus is nearly certainly the *coronal*. Its relations on the two sides are similar, but while on the left it is simple, on the right it forks slightly at its superior or dorsal end, and in its middle length it is connected with a very short horizontal sulcus (*b*), the identity of which is not clear.

There is no trace of a pseudosylvian sulcus on either side of the brain.

Dorso-laterally the neopallium is marked by a sulcus which, starting at the back of the hemisphere, runs straight forward, parallel to the middle line, for about 2 cms., and then, curving down towards the rhinal fissure, ends on the right side, about 7 mm. from that fissure, but on the left actually joins it, or very nearly so. This must be the *suprasylvian sulcus*. Though small and not so strongly arcuate as in the higher Ungulates, it is of the typical Ungulate form in the strength of its posterior branch. Near its caudal end the posterior limb of the suprasylvian is joined by a very short sulcus (*c*), which lies external to it. This sulcus, though minute, is constant on both sides.

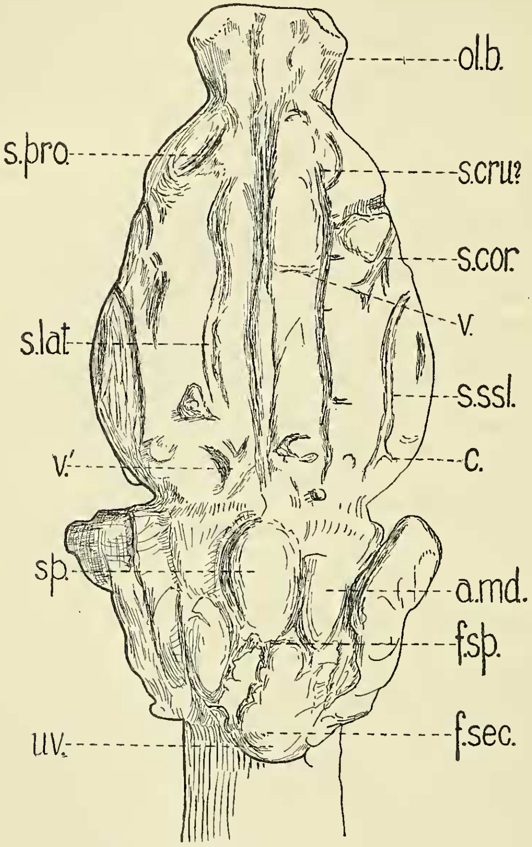
Midway between the suprasylvian sulcus and the rhinal fissure, and within the curve of the former, there is a short deep horizontal sulcus about 5 mm. long on the right side, and about twice that length on the left. This sulcus is exactly analogous in position to a similar short one in *Orycteropus*. For purposes of reference it will be spoken of as sulcus "*d*."

On the *dorsal surface* of the neopallium (text-fig. 157, p. 890), running in general parallel to, and on an average about 7 mm. from, the middle line, is a deep sulcus, which extends from very near the olfactory peduncle to the posterior surface of the hemisphere. This long furrow bears several branches and is really compound. On the left side of the brain, the most anterior part of it, about 1 cm. long, lies further from the middle line than the rest of the furrow, and was probably not directly continuous with it, though in the cast there is a connection by means of a shallow depression. This short sulcus must be the *prorean*. On the right side it is directly continuous with the rest of the sulcus, which is clearly the *lateral*. The relation between the prorean and lateral sulci is exactly as in *Orycteropus*.

The large lateral sulcus, though roughly parallel to the middle line, is by no means straight, and pursues a sinuous course along the hemisphere. On the right side it has two very short branches going outwards from it, at distances respectively of 1·5 and 3·3 cms. from its caudal extremity.

At the junction of the prorean and lateral sulci on each side there is another sulcus, a few millimetres in length and running straight forward. What exactly this represents is not clear. It may possibly be a rudiment of the *crucial.*

Text-fig. 157.



Dorsal view of brain-cast of *Anoplotherium.*

Lettering as in text-fig. 155, with addition of *a.md.*, area medullaris; *f.sp.*, fissura suprapyramis; *s.cru.*?, crucial sulcus (?); *s.lat.*, lateral sulcus; *sp.*, suprapyramis; *s.pro.*, prorean sulcus; *uv.*, uvula; *v.*, *v'.*, vessels.

At this point a couple of blood-vessels, marked on the dorsal surface of the cast, may be mentioned. On the right side, a small transverse ridge in the middle of the hemisphere and near the middle line may represent the course of one of the meningeal vessels or of a branch of the internal carotid artery. Branches of this latter artery probably account for some of the obscurity of the brain-surface behind the orbital fissure, where the cast shows the marks of the fronto-parietal suture.

Posteriorly, between the lateral sulcus and the middle line, traces of a spacious paired vessel (v') are seen. This is formed by two branches, one of which strikes out from the median line, while the other comes inwards and backwards from the surface of the brain. The main trunk, from its direction, seems to have gone round the tentorium and to have joined the transverse sinus. It was probably a vein collecting blood from the superior surface of the hemisphere.

Cerebellum.

The general proportions of this part of the brain have already been given. The cast does not, of course, show the minute folding of the cortex characteristic of a fresh specimen, but the main areas and the chief fissures are distinctly marked.

The most striking feature of this organ in *Anoplotherium* lies in the small size of the lateral lobes. This is probably a primitive feature, since, in a comparative series, evolution in the cerebellum is chiefly marked by the development of these parts [4].

The three fundamental divisions of the cerebellum are indicated by transverse fissures marked on the vermis.

The *fissura prima* is not very clearly shown, but there is a suggestion of a groove in the place where it nearly certainly must have been situated, on the dorsal part of the anterior face of the vermis.

The *fissura secunda* is clearly shown on the posterior surface of the vermis, marking off from the rest of the cerebellum a smooth hemispherical area, which faces posteriorly and is undoubtedly the *uvula*—the anterior division of the lobus posticus.

The whole of the dorsal part of the vermis belongs to the *lobus medius*. It is divided into two almost exactly equal parts by a transverse fissure, which can be nothing but the fissura suprapyramis. The vermis of the median lobe shows a twist such as is seen in a great number of mammals of different groups, and which gives a marked asymmetry to the organ.

To the sides of the suprapyramis—that part of the vermis of the median lobe anterior to the suprapyramidal fissure—lie triangular depressed areas indicating the exposure of white matter such as is found in many small mammals including most Marsupials, Rodents, Bats, etc. [5]. For this region Elliot Smith has suggested the term "*area medullaris*."

To the sides of the pyramis lie the indefinite masses of the *lateral lobes*, the small size of which has been commented on above. Their irregular form adds greatly to the asymmetry of the whole organ.

To the outside of the lateral lobes lie the probably relatively large *floccular lobes*. These can be traced as being connected behind, in the usual manner, to the pyramis. Below, they rest on the periotics and fill in the floccular fossæ. Their exact extent cannot be determined, owing to the continuity of their casts with those of the transverse sinuses.

Such a primitive form of cerebellum *in an organ of this size* is unknown, except in Marsupialia (*Macropus* and *Thylacinus*) [**6**].

Brain-stem.

In cranial casts this region is never represented with any accuracy, owing to the fact that the nerves and vascular spaces, which lie below the brain, obscure the outlines of the latter.

Conspicuously shown (text-fig. 156, p. 887) to the outside of the pituitary region are the courses of the nerves escaping by the sphenoidal fissure (which, as mentioned above, is confluent with the foramen rotundum) and by the foramen ovale.

The course of the trigeminal nerve can be followed from the outside of the region of the Pons Varolii, along a groove in the alisphenoid to the foramen ovale, through which it gave off its mandibular branch, and then, still lying in a groove on the bone, the second and first branches ran forward to pierce the skull with the third, fourth, and sixth nerves through the sphenoidal fissure. Occupying the centre of the figure formed by these two pairs of foraminal casts, the pituitary body is represented, but the extreme shallowness of its fossa makes it very inconspicuous. The posterior clinoid processes leave a scarcely noticeable impression on the plaster.

As to the divisions of the rest of the brain-stem nothing can be distinguished. It only remains to describe the casts of the periotic region, of the foramina for the veins of the sinus, and of the last cranial nerves.

The periotic bone has left an irregular crater-like scar on the side of the cast (text-fig. 155, p. 886). This hollow is walled by various nodose elevations, which are chiefly casts of parts of the transverse sinus. In the centre of the "crater" a tiny ridge represents the passage through the internal auditory meatus and the Aqueductus Fallopii of the VIIIth and VIIth nerves. The upper boundary of the crater is formed by the cast of the floccular fossa. In front and below is the cast of the foramen lacerum medium, from which a slight ridge runs forward on the base of the brain to meet its fellow of the other side below the pituitary fossa. This ridge may have some connection with the course of the internal carotid. Below and at the back of the periotic depression, an elevation represents the foramen lacerum posterius. At the back of the floccular lobe of the cerebellum, a tiny knob marks the position of the mastoid foramen (text-fig. 156, *m.f.*).

On the side of the medulla oblongata, in line with the jugular foramen, the exit of the XIIth nerve is represented by a tubercle which is the last feature to be seen on the cast.

At this point a summary of the resemblances between the brains of *Orycteropus* and *Anoplotherium* may not be out of place. The Aard-Vark's brain has been described as differing from a primitive Ungulate type only in a higher development of the olfactory parts. The only other important contrast with the

Ungulate brain lies in the insignificance of the suprasylvian sulcus compared with the lateral, which is the reverse of the usual condition found in that group [4].

The brain of *Anoplotherium* has the general proportions of that of *Orycteropus*, and the "smell-brain" is nearly as well developed. The horizontal continuous rhinal fissure in the brain of the first agrees with the usual condition in the second. The relations of the orbital, prorean, and lateral sulci agree in both. The suprasylvian sulcus of the Anoplothere is much more developed than in *Orycteropus*, but its size in relation to the lateral sulcus is intermediate between the usual Ungulate condition and the state of affairs in *Orycteropus*. The brain of the Aard-Vark has long been known to approach the Ungulate type, and in *Anoplotherium* we have an Ungulate which somewhat approaches the Tubulidentate type.

On the ventral surface, the differences between the two brains are practically all accounted for by the different degrees of macrosmatism. In the cerebella there are no striking similarities, but there is nothing to contradict a relationship.

If cerebral anatomy be of any systematic value, the view that *Anoplotherium* and *Orycteropus* arose from a common, though necessarily remote, ancestry can hardly be doubted.

In conclusion, I must emphasize my indebtedness to Prof. Elliot Smith, whose notes on the brain-cast I have freely used, and who has given me a great deal of help in many other ways. My thanks are also due to Dr. Andrews and Mr. D. M. S. Watson for kindnesses received at the British Museum.

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